DEPARTMENT OF HEALTH AND HUMAN SERVICES Public Health Service

National Institute for Occupational
Safety and Health
Atlanta Field Office
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HETA 2004-0055

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Dear Mr. Beane:

On November 19, 2003, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from Michael S. Young, Federal Security Director at the Cleveland Hopkins International Airport (CHIA), Cleveland, Ohio. The request was signed by you, Assistant Federal Security Director, for Michael S. Young on behalf of Transportation Security Administration (TSA) employees. The HHE request indicated that some female employees who work as TSA screeners were experiencing health problems possibly related to their work environment. In particular, the request identified employee concerns regarding exposures to radiation (X-rays) from the explosive detection system (EDS) machines used to screen checked baggage. Reported health problems included menstrual irregularities, including menstrual pain and spotting, and ovarian cysts. In response to this request, NIOSH investigators surveyed the CHIA on February 4-5, 2004. This final report describes our activities, findings, and recommendations regarding this site visit.

Introduction

The purpose of the site visit was to review the issues of concern, interview female TSA screeners about their health concerns and work activities, and review pertinent safety and health program information. This latter information was obtained to help determine the scope of the problem and help direct any follow up investigation. Prior to the site visit, we reviewed reports from evaluations of employee concerns conducted by Linda Nauman, TSA Training Coordinator, CHIA (November 7, 2003) and Kenn Paprocki, TSA Screening Supervisor, Environmental Health and Safety Office, CHIA (November 7, 2003). Additional research prior to the site visit included a literature search for studies evaluating X-ray exposures and menstrual irregularities.

Background

Baggage Screening

In 1975 the Federal Aviation Administration (FAA) adopted rules regarding the use of cabinet X-ray systems to screen carry-on baggage. Since 1975, the number of X-ray screening machines has increased as the detection capability has improved. One of the most significant equipment improvements over the past 25 years has been the introduction of computed-aided tomography (CAT) X-ray scanning machines to detect explosive materials in passenger and checked baggage. In 1994, the FAA approved the use of CAT machines as certified explosive detection systems (EDS); in the fall of 1995, they began installing these X-ray screening machines.

Carry-on baggage of airport travelers is examined using Threat Image Protection Ready X-ray (TRX) machines, typically located at passenger check points. The TRX units at CHIA were manufactured by Heimann and Rapiscan. For checked baggage, TSA workers use more elaborate (and more powerful) EDS equipment as previously described to create a three-dimensional image of the checked bag. The two manufacturers of EDS machines in the TSA system, L3 and CTX InVision, were both in use at CHIA at the time of this evaluation and were the focus of this survey. In addition to the EDS system, TSA uses Explosives Trace Detectors. These units do not use X-rays and were not part of this evaluation.

TSA

This TSA, which was created on November 19, 2001, protects the Nation's transportation systems to ensure freedom of movement for people and commerce. At the time of our evaluation there were approximately 215 TSA passenger screeners and 185 TSA baggage screeners at CHIA, with about 44 vacant TSA screener positions. Due to this shortage of TSA screening staff, vacation time had been curtailed. TSA screeners have no union representation.

Airport Description

The CHIA was built in 1954 and began as the first municipally-owned airport in the United States. The City of Cleveland and the Department of Port Control own and operate CHIA, which is currently undergoing a $1.4 billion expansion. In 2001, CHIA was the 34th largest airport in the country in terms of passenger numbers according to Airports Council International. There are 22 different airlines providing service to more than 13 million passengers per year, and CHIA is the principal air carrier airport serving Northeast Ohio, a region with a population of 4.1 million.

The airport is located in an urban setting approximately ten miles southwest of downtown Cleveland, Ohio. Passenger terminals consist of a 935,000-square foot terminal building with four attached concourses, Concourse A-D. The four concourses support 64 jet-only gates and three additional gates accommodating 25 commuter-only aircraft positions. Airfield facilities consist of three active runways, including two closely spaced parallel runways with a northeast-southwest orientation, and a crosswind runway with an east-west orientation.[1]

Actions Taken

On February 4, 2004, NIOSH investigators Marilyn S. Radke, MD, Amee G. Patel, MPH, and Gregory Burr, CIH, met with you and employee and management representatives from the TSA in an opening conference held at TSA offices near the CHIA. During this meeting, we provided information about NIOSH, reviewed the scope of our activities, and discussed specific issues and concerns. Following this meeting, we conducted a walkthrough survey of the CHIA passenger and baggage screening areas and spoke with TSA screeners. On February 5, 2004, we measured radiation at various locations around the EDS machines; interviewed employees at their work stations concerning their work environment; and conducted voluntary, confidential, medical interviews with interested employees. No medical records were made available for review. We were accompanied by TSA management during our initial walkthrough survey and all subsequent activities except for the conduct of voluntary, confidential, medical interviews with employees. No photographs were taken.

Radiation measurements

Spot radiation measurements were taken using a hand-held, ion chamber, survey meter manufactured by Inovision (Cleveland, Ohio). The detector consists of a pressurized 230 cubic centimeter (cc) air ionization chamber and is calibrated to measure in radiation exposure rate units of roentgens per hour (R/hr) for gamma and X-radiation in the energy range of 20 kilo electron volts (keV) to 2 mega electron volts (MeV), an energy range suitable for the X-rays potentially emitted from the EDS machines. The accuracy and precision of an Inovision meter is within 10 and 5% of the reading, respectively. While the Inovision survey meter can accurately measure a very wide range of radiation rates (from 0 to 5,000,000 microR/hr [μR/hr]), the radiation rates measured outside an EDS machine will typically range from 0 to 300 μR/hr.

The following checked-baggage and checkpoint areas were toured and surveyed:

- Concourse C Bag Room – 6 L3 machines and 1 CTX machine
- Concourse C Passenger Checkpoint – 6 Rapiscan machines
- Concourse B Passenger Checkpoint – 4 Heimann and 1 Rapiscan machines
- Concourse A Passenger Checkpoint – 1 Heimann machine
- Lobby Area – 2 CTX machines

On the L3 and CTX baggage screening machines, the following areas were checked for radiation:

- Entrance curtain (while curtain strips were either stationary or moving)
- Just inside the entrance curtain
- Entrance tunnel gap (if present)
- Along access panels
- Along taped areas
- Exit tunnel gap (if present)
- Exit curtain (while curtain strips were either stationary or moving)
- Just inside the exit curtain

On checkpoint baggage screening machines, the following areas were measured for radiation along with any area specified by personnel working with the machines:

- Entrance curtain stationary (X-ray on) and moving
- Enclosed area in front of entrance curtain
- Along access panel
- Exit curtain stationary (X-ray on) and moving

Spot measurements were also taken at checked-baggage screening machines (CTX) located in the ticketing area of the airport. These measurements were taken along the entrance and exit curtains.

Menstrual Abnormalities and Ovarian Cysts

Menstrual abnormalities, including menstrual irregularities, pain and spotting, may be described in three categories: (1) cycle length or rhythm, (2) bleeding pattern characteristics, and (3) the presence of pain. Amenorrhea, the complete absence of menses, is the most extreme disruption of cycle rhythm and is either primary or secondary. Primary amenorrhea is the failure to menstruate by age 16 years. Secondary amenorrhea is cessation of menses for three months or longer before age 40. Polymenorrhea is menstrual cycles at intervals of fewer than 18 days. Polyhypermenorrhea is periods of heavy flow occurring more frequently than normal. Oligomenorrhea is infrequent menstrual periods with an interval of 40 to 45 days between periods. Metrorrhagia is uterine bleeding outside the menstrual period. Irregular cycles are variations of more than five days in an individual's cycle length. The occurrence of abnormally short or long cycles increases seven years before menopause.[2]

Abnormal bleeding pattern characteristics include excessive flow called menorrhagia or hypermenorrhea. Painful menstruation is called dysmenorrhea and includes symptoms such as lower abdominal cramps, backache, aching thighs, headache, nausea, diarrhea, loss of appetite, irritability, and poor concentration. Primary dysmenorrhea is not linked to an obvious physical cause while secondary dysmenorrhea is related to pelvic disease.[2]

It is estimated that approximately 8-28% of working women experience menstrual abnormalities such as amenorrhea, dysmenorrhea, hypermenorrhea, and metrorrhagia. Risk factors associated with abnormal menstruation include age (immediately after menses begin and later near menopause); both underweight and overweight (amenorrhea is associated with a decreased ratio of body fat to lean body mass); vigorous exercise such as long-distance running, dancing and athletics (amenorrhea and oligomenorrhea); pregnancy; nulliparity or never giving birth (amenorrhea and dysmenorrhea); breast-feeding (may stop menstrual periods for up to 6 months after delivery); female genital tract disorders (cancer, infection, polyps, fibroids, endometriosis, adhesions, anatomic abnormality) and systemic illnesses (blood disorders, kidney disease/dialysis, thyroid disease, iron deficiency, diabetes, systemic lupus erythematosus, Crohn's disease, pituitary disease, Cushing's syndrome, stroke, sarcoidosis, acute febrile illness, liver disease, multiple sclerosis, tuberculosis); various medications (anticoagulants, sedatives, steroids, and excessive use of aspirin); contraceptive methods (birth control pills, intrauterine devices/IUD, and tubal ligation may influence menstrual cycles in a variety of ways); and socioeconomic and psychological factors, including stress (amenorrhea and dysmenorrhea and possibly oligomenorrhea and hypermenorrhea), smoking (amenorrhea and dysmenorrhea), and alcoholism (amenorrhea).[2]

There have been few studies to assess occupational exposures related to menstrual abnormalities and the findings of some studies remain unconfirmed. Toxic exposures can change the menstrual cycle by several means, including inhibition or damage to follicles in the ovaries, effects on the central nervous system leading to hormone changes, damage to hormone-secreting organs, and disruption of the complex hormone balance that regulates ovulation and menstruation.[2]

Menstrual disorders have been associated with exposure to formaldehyde (occupations such as ink making and embalming); solvents such as benzene, toluene, xylene, and perchloroethylene (dry cleaning plants); styrene (unconfirmed); hydrocarbons (petroleum workers); trinitrotoluene (explosive manufacturing); certain drugs such as estrogens (estrogen plant workers), cytotoxic drugs (nursing); and physical hazards such as vibration (textile manufacturing) and shift work (conflicting results). Multiple factors (vibration, shift work, altitude changes, and solar radiation) are associated with menstrual disorders in female flight attendants; however, menstrual function has been shown to revert to preflight status with longer jet flight experience.[2] Shift work and sleep disturbances are associated with menstrual changes in female nurses.[3] Earlier onset of menopause has been associated with race (African-Americans), stress (African-Americans), irregular cycles, current smoking, and being on a weight-reduction diet. It is estimated that almost half of the female workforce have one of the following risk factors that strongly influence menstruation: use of oral contraceptives or intrauterine device, recent pregnancy, hysterectomy, primary amenorrhea, history of cancer of the reproductive organs, and age over 40 years.[2]

Most ovarian cysts in women of reproductive age are physiological (normal) functional cysts of the ovarian follicle or corpus luteum, but some are pathological masses that need to be identified and distinguished from ovarian cancer.[4] Simple ovarian cysts also occur in approximately 3 to 15 % of postmenopausal women, and need to be distinguished from pathological masses such as ovarian cancer.[5] A review of the available medical literature reveals no association between ovarian cysts and workplace exposures.

Evaluation Criteria

For physical agents such as ionizing radiation, the primary sources of environmental evaluation criteria for the workplace are: (1) the National Council on Radiation Protection and Measurements (NCRP) limits of exposure to ionizing radiation,[6] (2) the International Commission on Radiological Protection (ICRP) limits of exposure to ionizing radiation,[7] (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs),[8] (4) the U.S. Department of Energy (DOE) standards for external and internal exposure,[9] (5) the U.S. Nuclear Regulatory Commission (NRC) occupational dose limits,[10] (6) the U.S. Environmental Protection Agency (EPA) federal radiation protection guidance for occupational exposure,[11] (6) the Food and Drug Administration (FDA) performance standards for ionizing radiation emitting products,[12] (7) the U.S. Department of Transportation (DOT) radiation limits for transportation of radioactive materials,[13] (8) the International Air Transportation Association (IATA) radiation protection and quality assurance programs,[14] and the International Atomic Energy Agency (IAEA) occupational radiation protection safety standards.[15] Employers are encouraged to follow the limits most applicable to the work environment of the specific agency and to use the more protective criteria.

NIOSH investigators selected the FDA radiation-leakage limit for radiation emitting products as the most applicable limit to use for comparison during this evaluation.[12] This regulation states that "radiation emitted from the cabinet X-ray system shall not exceed an exposure of 500 μR in one hour at any point five centimeters (approximately two inches) outside the external surface. It is important to note that background radiation (from cosmic rays and naturally occurring radioactive materials), and to which all of us are exposed, typically ranges from 0 to 20 μR/hr. It is important to remember that the above-mentioned FDA limit is for radiation leakage, and does not necessarily represent the radiation dose that an individual may receive. Selecting the most appropriate radiation dose limits and radiation monitoring criteria for TSA screeners is difficult, because the role of this "security-based" workforce falls outside the traditional roles of "radiation workers." The ambiguities and inconsistencies in the federal regulations, the recent changes to the ICRP recommendations, the use of radiation-producing technology with higher radiation exposure potentials, and the growing world-wide application of this new technology have created a need to re-assess the merits of applying dose limits developed for "radiation-workers" to "security-based workers." Currently, NIOSH is conducting an independent study to determine the potential for radiation exposures to employees who operate X-ray generating machines at airports.[18] As this study progresses, NIOSH researchers will work with TSA, OSHA and other federal or state agencies to address this issue and develop recommendations associated with radiation monitoring for TSA employees.

For this evaluation, NIOSH investigators considered dose limits based on criteria adopted in 1999 by the Federal Aviation Administration. These exposure guidelines were adopted from radiation exposure limits contained in the 1998 American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs)® for Chemical Substances and Physical Agents and Biological Exposure Indicies (BEIs)® booklet[16] in lieu of outdated Occupational Safety and Health Administration (OSHA) standards.[17] These ACGIH limits, based on the guidance of the ICRP, are 5,000,000 microrem per year (effective annual dose, whole body) and 50,000,000 microrems per year (annual equivalent dose to the skin, hands and feet).[a]

Findings

Radiation Exposure

We conducted spot measurements of the radiation leakage rates around all of the EDS machines at CHIA on February 5, 2004. Table 1 summarizes the results from the checked-baggage screening machines in Concourse C, the primary passenger terminal at CHIA. Measurements were taken at the entrance and exit curtains of the machines. To evaluate the impact that baggage may have on these curtains, readings were taken while the strip curtains were either stationary or moving. A spot check of the radiation level was also made on the interior of the EDS machine, just past the outer strip curtain on both the entrance and exit ends. This radiation measurement would approximate the exposure that a worker's hand may momentarily receive while pushing or pulling a bag from the machine.

All measurements were within the FDA radiation-leakage limit of 500 μR in one hour at any point five centimeters (approximately two inches) outside the external surface. We noted that TSA employees typically stood to the side of the entrance and exit belts, and not directly in front of the entrance and exit. Also, employees rotated tasks (operating the computer, loading/unloading bags, screening bags for explosives). All of these work practices further reduce X-ray exposures during a typical workday. Appendix A provides an example of the dose received by a screener working on a CTX 5500 machine.

Checkpoint machines (Rapiscan and Heimann) in Concourse A, B, and C were also measured for radiation. The area around the entrance curtains ranged from background levels (0 to 20 μR/hr) to 120 μR/hr. The area around the exit curtains ranged from background levels to 150 μR/hr.

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a There is approximately a one-to-one conversion between the radiation rate (measured in μR per hour) and the effective radiation dose (expressed in microrems).

The areas around the entrance/exit tunnels, access panels, and computer monitor were at background levels. We observed that the X-ray indicator lights on these machines were often blocked by boxes of gloves or paper taped over the light. Like the EDS workers, TSA personnel working at passenger checkpoints rotated tasks (computer stations, loading/unloading bags, metal detectors, screening passengers), a practice which would further reduce their radiation exposure.

Table 1
Radiation Measurements on EDS Machines in Concourse C, Checked-Baggage Area
Cleveland Hopkins International Airport, February 5, 2004 (HETA 2004-0055)

Location	Radiation Leakage Rate‡	Comments
Entrance curtain		
Stationary	Background▪ to 150	Curtains appeared in good condition (no missing or curling strips were observed).
Moving	60 to 300	
Inside♦	1400 to 1600	
Exit curtain		
Stationary	Background▪ to 60	Curtains appeared in good condition (no missing or curling strips were observed).
Moving	30 to 250	
Inside♦	1500 to 1900	
Miscellaneous areas†		
Access panels	Background to 60	All access panels were in good condition.
Taped areas	Background to 60	Minimum taped areas were observed.
Tunnel Gaps	Background to 80	Tunnels appeared tightly positioned with the gantry.
Exposure guidelines		
	5,000,000 microrems (whole body)▲ 50,000,000 microrems (arms and legs)▲	These exposure guidelines are provided to help interpret the radiation leakage rates. They are based on the professional judgment of the NIOSH investigators and are consistent with the NRC dose limits. Although OSHA Permissible Exposure Limits for radiation exposure exist, they are much higher than those listed in this table and may not be applicable for the TSA workforce. There are no applicable NIOSH Recommended Exposure Limits.

Comments:

‡ Microroentgens (μR) per hour. It is important to note that these radiation leakage rates were taken within five centimeters of the surface of the machine. The radiation rates drop quickly to background levels (0 to 20 μR per hour) as you move one to two feet from the machine

▪ Background radiation from natural sources and cosmic radiation typically ranges from 0 to 20 (μR) per hour.

♦ Measurement taken on the interior of the first row of curtains. This measurement approximates the short-term exposure to the hands of a TSA worker when guiding or removing a bag from an EDS machine, but would not represent a whole-body exposure to the worker.

† Where applicable, radiation leakage measurements were taken around access panels of the EDS machines, at any areas where lead tape had been used to seal gaps in the machines during initial set-up, and at gaps between the tunnels and the gantry units. These measurements were taken within five centimeters (approximately two inches) of the surface of the EDS machine.

▲There is approximately a one-to-one conversion between the radiation rate (measured in μR per hour) and the effective radiation dose (expressed in microrems). See Appendix A for an example in calculating a radiation dose for a screener.

Medical

Individual interviews were conducted with ten employees concerned about health problems possibly related to radiation exposures from the X-ray machines used to screen passengers and baggage. These employees reported working in multiple sites around the airport, including Checkpoints A, B, and C, and the baggage room. TSA screeners commonly rotate among workstations and most have worked at many of the various checkpoints and baggage room locations at various times. Specific times and dates during which individual employees worked at each specific site were not reviewed. No employee reported changing jobs to avoid working at a specific location or to avoid working with X-ray machines. Employees reported diagnosed thyroid disease, bronchitis, cervical cancer, and menopause. Employees also reported current symptoms consistent with menopause and menstrual disorders (dysmenorrhea and hypermenorrhea). There were no reports of diagnosed ovarian cysts.

Discussion

Radiation Exposure

Spot measurements indicate that the baggage screening machines are below the FDA radiation-leakage limit of 500 μR/hour for radiation-emitting products. One L3 machine (Station 8, Serial #AN6340B513) showed slightly higher radiation spot readings than other machines when the entrance curtain was moving. However, the measurement was taken when bags were being rapidly loaded into the L3 machine with little spacing between bags (i.e. one bag was lifting the interior curtain while the next bag was entering the machine and lifting the exterior curtain.) Since the X-ray on L3 machines remains on while the machine is operating, lifting and moving the interior and exterior curtains simultaneously (due to the arrangement of baggage on the conveyor) can potentially allow more radiation to leak from the machine's entrance or exit. Although this slightly higher radiation leakage rate may still be below the FDA guidelines, this work practice can result in unnecessary exposure.

Distance and position to the EDS machine play a very important role in the amount of radiation exposure. The farther away employees stand from the baggage screening machines, the lower their exposure. Radiation rates drop to background levels (0 to 20 μR/hr) by moving just one or two feet away from the EDS. Work position is equally important. For example, we observed TSA personnel frequently standing to the side of the entrance and exit openings of the machines, a location which further reduces their exposure, because they are not in the direct path of X-rays that may leak from the entrance and exit curtains.

The time people spend near the source of radiation can increase or decrease the amount of radiation exposure. Employees rotated tasks from loading and unloading bags to hand-checking bags to physically moving bags from the conveyor belt to the machines. Taking into account very low or no radiation exposure from the machines, the average radiation exposure would be below any exposure limits.

Radiation is not absorbed and does not accumulate in the body like chemicals. Once the X-ray is turned off, the radiation level within a machine immediately dissipates, and there is no residual radiation. With the CTX and checkpoint baggage screening machines, the X-ray is turned on only when baggage is inside the X-ray gantry. For this reason employees should avoid reaching into the machine when the X-ray is active. We did notice that the “X-ray on” indicator lights on several checkpoint baggage screening machines were blocked by boxes and other items, making it difficult for employees to see the light and to know whether the X-ray is on or off. Unlike the CTX and checkpoint machines, the X-ray in the L3 machines remains on when the machine is powered and running. Thus, employees should minimize reaching into the L3 machine to adjust baggage.

Medical

Discussions during the opening meeting and informal conversations with employees during the site visit indicated that the primary concern was whether or not a health hazard existed from working with the X-ray machines used to screen baggage. We did not find any studies in the medical literature that have examined the relationship between X-rays from baggage screening machines or the low levels of radiation associated with use of these machines and the health problems reported in this request. Based upon what is presently known about radiation exposures from X-ray machines used to screen baggage, there is no medical evidence to support the perception that work-related exposures in the airport are responsible for the reported menstrual irregularities among employees. There were no reported medical findings to support the diagnosis of a work-related illness due to the X-rays from baggage screening machines. There were reported medical diagnoses, including thyroid disease, cervical cancer, and menopause, which are not work-related and are known to cause menstrual irregularities.

On March 26, 2003, TSA Management submitted a request for NIOSH to perform an independent study to determine the levels of radiation emissions from the various TSA screening equipment. In response, NIOSH initiated a study of twelve airports. The three objectives of the NIOSH study are to:

1. assess the work practices, procedures, and training provided to TSA employees who operate machines that generate X-ray;
2. characterize the radiation exposure among employees who operate theses machines; and
3. determine if employees who operate these machines are exposed at sufficient levels to require routine monitoring with radiation dosimeters.

The NIOSH study framework can be found on the NIOSH website at www.cdc.gov/niosh by typing “airport screeners” in the box under “Search NIOSH website” and clicking on “Go”. Upon completion of this study, NIOSH will prepare a written report of its findings, conclusions, and recommendations regarding the need to monitor workers with radiation badges.[18]

Recommendations

The following recommendations are provided to help minimize exposure to X-rays from baggage screening machines, and to increase employee awareness of the importance of the proper use of this equipment:

1. Implement a management plan for proper operation and maintenance of X-ray machines used to screen baggage, including the following: maintaining strip curtains; keeping indicator lights uncovered and visible to employees; and using keys to "power down" units (instead of relying on access panel interlocks).
2. Provide training to employees in the safe operation of X-ray machines used to screen baggage and in techniques effective in minimizing employee exposure to X-rays, such as using wooden dowels to push baggage through machines and standing/sitting a safe distance (at least two feet) from machines when possible.
3. Post survey results and inspection results on X-ray machines used to screen baggage. Share all information with employees regarding maintenance of baggage screening machines, inspections, and testing performed by the manufacturer and technicians.
4. Improve communication among the Health and Safety Committee, management, and employees to facilitate the exchange of information and concerns about X-ray machines used to screen baggage as well as other environmental conditions at CHIA. Information available at the following NIOSH website on the ongoing TSA study may be useful: http://www.cdc.gov/niosh/topics/airportscreener/faqxray.html
5. Advise employees with health concerns regarding working with baggage screening machines to see their health care provider. It may be useful to seek evaluation by a physician who is residency trained or board certified in occupational medicine and is familiar with the types of potential exposures and health effects of concern to employees. Occupational medicine physicians can be located through a variety of sources, including universities, the Association of Occupational and Environmental Clinics at www.aoec.org and the American College of Occupational and Environmental Medicine at www.acoem.org. It may be useful to provide the physician with a copy of this letter.
6. Follow recommendations developed as a result of NIOSH Health Hazard Evaluation #20030206 currently in progress with the TSA. We expect that the report will be posted on the NIOSH website at www.cdc.gov/niosh in 2005.

For the purpose of informing affected employees, copies of this report and the attached highlights page should be made available to all CHIA employees. This can be accomplished by posting the report in a prominent place normally used for employee communication for a period of 30 calendar days. Also enclosed with this letter are multiple copies of a one-page document entitled, "Highlights of the NIOSH Health Hazard Evaluation" and a one-page document entitled, "National Institute for Occupational Safety and Health: Do I Need a Dosimeter? Health Hazard Evaluation #2003-0206." The highlights document outlines the findings of the evaluation in an easy-to-read format. The dosimeter questions document outlines the ongoing NIOSH HHE #20030206 with TSA. Please feel free to make additional copies of the report, the highlights document, and the dosimeter questions document as needed. Thank you for the cooperation and assistance we received during this evaluation. We hope that this report is useful in your efforts to provide a safe workplace. If you have any questions, please contact Dr. Marilyn Radke at (404) 498-2579 or Mr. Gregory Burr at (513) 841-4582.

Yours truly,

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Appendix A
TSA Worker Scenario: EDS stand-alone machine

Assumptions:

Machine type and exposure scenario: CTX 5500; hand just inside Exit Tunnel
X-ray is on EVERY time a bag is ejected from the machine (not likely).
Number of bags scanned during a push = 250 bags per hour
Number of times you reach just inside the lead curtain during that period = 175
Length of time your hand(s) is in the tunnel for each bag = 1 second
Number of hours this machine is operating at this level in a work day = 8 hours per day (not likely)
Number of hours you work unloading this machine = 8 hours per day (not likely)
Number of hours you work at this machine per week = 40 hours per week (not likely).
Number of weeks you work at this machine in a year = 50 (Note: This represents a typical work year)
Highest dose rate measured just inside the CTX 5500 exit tunnel curtain = 50,000 μR /hr (not likely)

Using these assumptions, we then calculate the dose to the hand(s)

$$175\ \frac{\text{reaches}}{\text{hour}} \times 1\ \frac{\text{hour}}{3600\text{ sec}} \times 8\ \frac{\text{workhours}}{\text{workday}} \times 5\ \frac{\text{workdays}}{\text{workweek}} \times 50\ \frac{\text{workweeks}}{\text{year}} \times 50{,}000\ \frac{\mu\text{R}}{\text{hour}} = \mathbf{4{,}861{,}000}\ \frac{\mathbf{mR}}{\mathbf{year}}$$

Comparison to the occupational limit:

The occupational dose limit to your hands is 50,000,000 microrem per year (1 microrem is considered equal to 1 μR for X-ray exposures). **This limit is recognized world-wide by the scientific community and it means that a worker can receive this much dose to their hands without experiencing the occurrence of any short-term radiation injury or significant risk of adverse long-term health effects in relation to the benefits to the individual and society.** So, our worst-case estimate is that your hands could be exposed to radiation levels about 10 times lower than the exposure limit. If we change our assumptions to something more realistic like unloading bags for about 1 hour per day (on average) for an entire work year, the dose estimate for your hand(s) would be about 610,000 μR /year (InVision CTX5500 machine), about 100 times lower than the limit.

NIOSH investigators have found that a screener is not likely to reach through the exit curtains of InVision 2500 or 5500 machines due to the exit velocity of the baggage and the thickness of the curtains. However, this practice was commonly observed with screeners working the L3 machines. If you run the same worst-case calculation for the L3 machine, the dose to your hands would be about 490,000 microrem per year, about 100 times lower than the limit. The difference is due to lower radiation levels inside the L3 exit and entrance tunnels vs. the InVision machines (5000 microrem/hr vs. 50,000 microrem/hr).

All of these estimates are based on an assumption that the EDS equipment is properly maintained and in FDA compliance.